Space Motion Imaging

From low Earth orbit and Near-Earth objects to…Mars?

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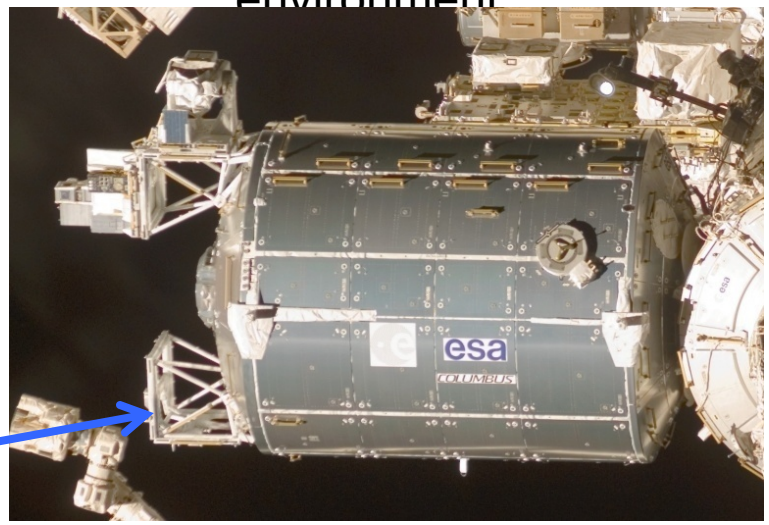
Current status on the ISS

- Canon G1 & JAXA provided Multi-protocol converter (MPC) currently used for in-cabin HDTV live and recorded video
- Transitioning to Canon 305 and new VSI h.264 encoder for video documentation and live downlink
  - Canon 305 also allows for file transfer
  - H.264 encoder provides better quality HD video with less bandwidth
- Increased use of Nikon Digital Single Lens Reflex cameras for video, high-dynamic range imagery, and unique time-lapse scenes
- Panasonic 3DA1 3D HDTV camera was on ISS from STS-135 to SpaceX-1
  - Proved all-in-one stereoscopic camera can provide useful 3D HDTV video
  - First experience with file based video workflow
  - After 19 months on orbit there were no visible pixel defects
    - Currently analyzing camera to determine actual number of dead pixels
    - Dead pixels masked by in-camera pixel correction algorithm

Next phase of video improvements on the ISS

- Digital cinema camera for documentary projects
  - Looking at commercial 4K or higher resolution cameras
- High Definition Earth Viewing Project
  - External Earth-viewing multiple camera payload using 4 commercial off-the-shelf HDTV cameras

- Primary objectives:
  - Validate space-based performance of the cameras
  - Demonstrate camera features and ability of cameras to survive harsh environment

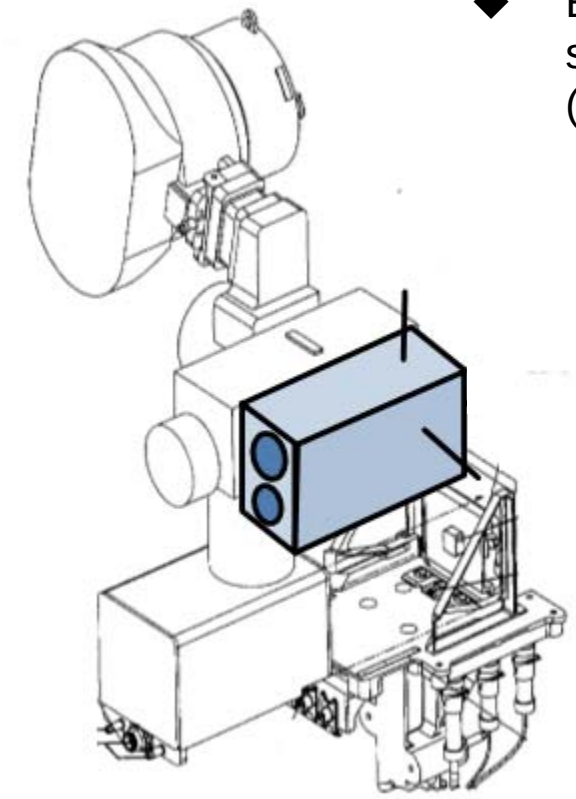


Installation Site (NADIR)

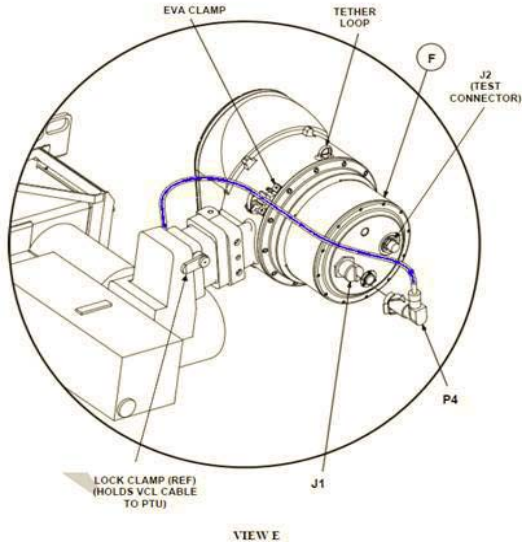
External HDTV Project

- Recently approved by NASA International Space Station Program Manager
- Attach a HDTV camera to the side of existing external analog camera housings
  - Saves having to develop a new pan & tilt system
  - Use external wireless communication system for camera control and video transmission
- Minimum requirements
  - Will include Zoom lens
  - 1280 x 720 progressive @ 60 frames-per-second
  - H.264 video encoding
  - Use commercial-off-the-shelf cameras
    - Camera selection process is underway
    - May use more than one commercial camera

External HDTV Camera Concept



- EHDV camera assembly is secured to the side of an External TV Camera Group (ETVCG) Color Television Camera (CTVC).
  - Camera assembly receives power from rerouted luminaire power cable.



- Capability to integrate one camera assembly at each of the 4 ETVCG locations.

Challenges for imaging from beyond low Earth orbit

- Radiation tolerance of camera sensors
  - Researching radiation hardening by design
    - PMOS sensors
- Command & Control
  - Human control of remote cameras may be impractical due to long communication links
  - Need a common command & control protocol for camera systems
- Integrity of communication links
  - Mars or Lagrange points will utilize disruptive communication links
  - Delay Tolerant Networking protocols may be best for video applications
    - Bundle Protocol, Liklider Protocol, others in development

Hemi-Cam concept for pan/tilt/zoom without moving parts

- Mechanical pan, tilt and zoom hardware subject to dust and regolith damage on Moon and Mars
- Multi-camera “stitching” and digital zoom on sensor
  - Over-sampling allows “zooming” from 1080 x 1920 sampling to 1280 x 720 sampling
  - Software “stitches” the imagery from multiple cameras to give the same effect as panning and tilting
- Intelligent software can be added to make the system aware of motion or sensitive to specific textures